

CLAIMS

1. A method for counting cells or fat droplets in milk on-line during milking of a milking animal, characterized by the steps of:

- 5 - flowing at least a portion of the milk as obtained during said milking of said milking animal through a measuring chamber (59);
- illuminating milk that flows through said measuring chamber;
- 10 - repeatedly recording two-dimensional digital images of illuminated milk that flows through said measuring chamber, said two-dimensional digital images being recorded through a lens system (49), preferably a microscope; and
- 15 - determining a somatic cell or fat droplet count score from said two-dimensional images by means of digital image processing.
2. The method of claim 1 wherein said at least portion of the milk flowed through said measuring chamber (59) is free from toxic additives.
- 20 3. The method of claim 1 wherein said at least portion of the milk flowed through said measuring chamber (59) is pure natural milk, optionally mixed with air, but free from any chemical additives.
- 25 4. The method of any of claims 1-3 wherein said repeatedly recordings of two-dimensional digital images are performed to obtain a spatial resolution better than about 5 microns, preferably better than about 2 microns, more preferably better than about 1 micron, and most preferably better than about 0.5 microns, in said two-dimensional digital images.

5. The method of any of claims 1-4 wherein said measuring chamber has a dimension (t) smaller than about 100 microns, preferably smaller than about 50 microns, and more preferably smaller than about 10 microns, in a direction parallel with the optical axis (61) of said lens system during said repeated recordings.

6. The method of any of claims 1-5 wherein said digital image processing includes the analysis of number, shape, size, structure, density and/or composition of particles found in each image as revealed by the reflection and/or transmission properties of the particles recorded spatially resolved by said camera system.

7. The method of any of claims 1-6 wherein said digital image processing includes the use of neural networks.

8. The method of any of claims 1-7 wherein said at least portion of said milk, which is flowed through said measuring chamber, is lead away from a milk line (13) of a milking machine used to collect the milk as obtained during said milking of said milking animal.

9. The method of claim 8 wherein said at least portion of said milk, which is lead away from said milk line, is brought back to said milk line or brought to a milk collecting container, after having been flowed through said measuring chamber.

10. The method of any of claims 1-7 wherein said at least portion of said milk is flowed through said measuring chamber (59) within a milk line (13) of a milking machine used to collect the milk as obtained during said milking of said milking animal.

11. The method of any of claims 1-10 wherein said milking of said milking animal is performed by an automated or semi-automated milking system, which comprises a plurality of teat

cups (11), each of which being connected to a respective milk line (13), which milk lines in turn are connected to a container (15) via a claw and a single milk line, wherein, during milking of the teats of said milking animal, said plurality of teat cups are attached to the teats of the milking animal and vacuum (23) is supplied to said container to draw milk through said milk lines, said claw, said single milk line and into said container.

12. The method of any of claims 1-10 wherein said milking of said milking animal is performed by an automated or semi-automated milking system, which comprises a plurality of teat cups (11), each of which being connected to a respective milk line (13), which milk lines in turn are connected to a container (15) wherein, during milking of the teats of said milking animal, said plurality of teat cups are attached to the teats of the milking animal and vacuum (23) is supplied to said container to draw milk through said milk lines and into said container, wherein said milk is drawn in separate milk lines (13) all the way to said container.

13. The method of any of claims 1-12 wherein said somatic cell or fat droplet count score is a count score of white cells.

14. The method of any of claim 11 or 12 wherein said container is provided with a plurality of milk output lines (29, 31); and said milk drawn through the milk lines and into said container is output through one of said plurality of milk output lines depending on said somatic cell or fat droplet count score.

15. The method of any of claims 1-14 wherein a content of fat is estimated from said two-dimensional images by means of said digital imaging processing.

16. The method of claim 15 wherein said content of fat is estimated from number and size of fat droplets in said two-dimensional images.

17. The method of claim 12 wherein

- a measuring chamber (59) is provided in each milk line;
- at least a portion of the milk drawn through the respective milk lines is passed through the respective measuring chambers;
- 5 - milk that flows through the respective measuring chambers is illuminated;

- two-dimensional digital images of illuminated milk that flows through the respective measuring chambers is repeatedly recorded, where said two-dimensional digital images are recorded through a lens system to obtain a spatial resolution better than about 5 microns in said two-dimensional digital images; and

- somatic cell or fat droplet count scores for milk drawn through the respective milk lines are determined from said two-dimensional images by means of digital image processing.

18. An apparatus for counting somatic cells or fat droplets in milk on-line during milking of a milking animal, characterized in:

- a measuring chamber (59), through which the milk as obtained during said milking of said milking animal is flowed;

- a light source system (63) for illuminating milk that flows through said measuring chamber;

- a two-dimensional camera system (51) including a lens system (49), preferably a microscope, for repeatedly recording two-dimensional digital images of illuminated milk that flows through said measuring chamber, where said two-dimensional digital images are recorded through said lens system; and

- a digital image processing system (35) for determining a somatic cell or fat droplet count score from said two-dimensional images.

19. The apparatus of claim 18 wherein said at least portion of the milk flowed through said measuring chamber (59) is free from toxic additives.

20. The apparatus of claim 18 wherein said at least portion of the milk flowed through said measuring chamber (59) is pure milk natural milk, optionally mixed with air, but free from any chemical additives.

21. The apparatus of any of claims 18-20 wherein said two-dimensional camera system provides for a spatial resolution in said two-dimensional digital images better than about 5 microns, preferably better than about 2 microns, more preferably better than about 1 micron, and most preferably better than about 0.5 microns.

22. The apparatus of any of claims 18-21 wherein said measuring chamber has a dimension (t) smaller than about 100 microns, preferably smaller than about 50 microns, and more preferably smaller than about 10 microns, in a direction parallel with the optical axis (61) of said lens system during said repeated recordings.

23. The apparatus of any of claims 18-22 wherein said digital image processing system is adapted to analyze number, shape, size, structure, density and/or composition of particles found in each image as revealed by reflection and/or transmission properties of the particles as recorded by said camera system.

24. The apparatus of any of claims 18-23 wherein said digital image processing system is adapted to use neural networks in determining said somatic cell or fat droplet count score from said two-dimensional images.

25. The apparatus of any of claims 18-24 wherein

- 5 - said milking of said milking animal is performed by an automated or semi-automated milking system, which comprises a plurality of teat cups (11), each of which being connected to a respective milk line (13), which milk lines in turn are connected to a container (15), wherein, during milking of the teats of said milking animal, said plurality of teat cups are attached to the teats of the milking animal and vacuum (23) is supplied to said container to draw milk through said milk lines and into said container; and
- 10 - said measuring chamber (59), through which said at least portion of said milk is flowed, is arranged within one of said milk lines (13).

15 26. The apparatus of claim 25 wherein said measuring chamber is defined by a light transparent plate (48) mounted in a wall of said one of said milk lines, through which said two-dimensional camera system is adapted to record said two-dimensional images; and an oppositely located substantially flat and parallel surface (55a).

20 27. The apparatus of claim 26 wherein said measuring chamber is open in directions being parallel with said light transparent plate and said substantially flat surface, and orthogonal to a general direction of the flow (44) of said at least portion of said milk.

25 28. The apparatus of claim 26 or 27 wherein said substantially flat surface is rotatable (65) around an axis being orthogonal to said light transparent plate and said substantially flat surface.

30 29. The apparatus of any of claims 26-28 wherein said substantially flat surface is an end surface of a rod (55).

30. The apparatus of claim 29 wherein said rod is light transparent to allow for illumination through said rod of said milk that flows through said measuring chamber.

5 31. The apparatus of any of claims 25-30 wherein said container is provided with a plurality of milk output lines (29, 31); and said apparatus further comprises a pump and regulator system (27) connected to said digital image processing system (35) for pumping said milk drawn through the milk lines and into said container out through one of said plurality of milk output
10 lines depending on said somatic cell or fat droplet count score.

32. The apparatus of any of claims 25-30 wherein

- each of said milk lines is provided with a measuring chamber, through which a portion of the milk drawn through the
15 respective milk line is passed;

- said light source system is adapted to illuminate milk that flows through each of said measuring chambers;

- said two-dimensional camera system is adapted to repeatedly record two-dimensional digital images of illuminated milk that
20 flows through each of said measuring chambers; and

- said digital image processing system is adapted to determine a somatic cell or fat droplet count score for milk drawn through each of said milk lines from said two-dimensional images.

25 33. The apparatus of any of claims 18-24 wherein

- said milking of said milking animal is performed by an automated or semi-automated milking system, which comprises a plurality of teat cups (11), each of which being connected to a respective milk line (13), wherein, during milking of the teats
30 of said milking animal, said plurality of teat cups are

attached to the teats of the milking animal and vacuum (23) is supplied to said teat cups through said milk lines to draw milk through said milk lines;

- each of said milk lines is provided with a measuring chamber, through which a portion of the milk drawn through the respective milk line is passed;

- said light source system is adapted to illuminate milk that flows through each of said measuring chambers;

- said two-dimensional camera system is adapted to repeatedly record two-dimensional digital images of illuminated milk that flows through each of said measuring chambers;

- said digital image processing system is adapted to determine a somatic cell or fat droplet count score for milk drawn through each of said milk lines from said two-dimensional images; and

- a directing means connected to said digital image processing system for directing milk drawn through each of the respective milk lines into a selected one of a plurality of containers depending on the respective somatic cell or fat droplet count score.

34. A milking robot comprising the plurality of teat cups (11), the plurality of milk lines (13), the container (15), and the apparatus for counting somatic cells or fat droplets of any of claims 25-33.